Small Explorer (SMEX) Announcement of Opportunity

Spartan 400 Spacecraft Opportunity

NASA is offering the baseline Spartan 400 spacecraft bus system and services, and two specific bus options for use by SMEX proposers as fixed price Government Furnished Equipment (GFE). The multi-year Spartan 400 bus provides the Explorer Program a new capability enabling missions which have large volume or mass requirements, and for missions which have a need for recovery of the hardware. The Spartan 400 is a recoverable spacecraft platform launched and retrieved by the Space Shuttle. Since mission requirements vary greatly, interested users are strongly encouraged to contact the Spartan Project Office (see below) to assess the Spartan 400 nominal capabilities and identify any mission unique requirements.

> Note: In this document, the term spacecraft (SC) means the science payload (SP) combined with the Spartan 400 spacecraft bus (SCB).

The NASA Spartan GFE and services include:

- Interface with the Shuttle Program, including integration and safety
  - Shuttle payload mission manager
  - Assistance with Shuttle safety and safety implementation
  - Integration of the spacecraft with the Shuttle
- Spacecraft bus hardware and software, and operations control system hardware and software, to support the nominal mission operations as described below
- Nominal science payload-to-spacecraft bus integration and testing, limited in scope and duration as described below
- Launch site support, launch and early orbit operations and retrieval operations
- During Science Mission Operations, spacecraft engineering data capture and anomaly recovery support

The PI is responsible for:

- Additional costs to satisfy mission unique spacecraft bus and services requirements
- Design, analysis, fabrication, integration, testing and environmental qualification of the science payload prior to integration with the spacecraft bus
- Delivery of the qualified instrument to GSFC at L-12 months
- Science payload-specific mechanical and electrical GSE
- Obtaining ground station support
- Submittal of science payload materials list and verifications
- Science payload safety data, analysis, and verification
- Support of: design reviews, I&T, launch site operations, launch, early orbit, and retrieval operations
- Spacecraft operations during the science mission
- Science data reduction and reporting

Deployment and retrieval orbit characteristics are those available for all Space Shuttle launched payloads. The optional propulsion system is available for missions with higher altitude and/or orbit maintenance requirements.

The optional articulated solar array system replaces the baseline fixed array and is available for missions requiring additional instrument power and/or solar array tracking during nominal off-sun pointing.

Shuttle Safety

When the proposed mission is a Shuttle payload, the proposer is required to plan and implement a system safety program that meets all Space Shuttle safety requirements imposed by the Johnson Space Center for NSTS payloads. The controlling safety documents are (NHB) 1700.7, Safety Policy and Requirements for Payloads Using the Space Transportation System; and (KHB) 1700.7, "STS Payload Ground Safety Handbook". The Space Shuttle Program typically requires 3 safety reviews. Proposers are advised that Space Shuttle safety requirements are particularly strict and may lead to unexpected design changes, additional test or analysis requirements, and associated cost increases which can be mitigated significantly, or entirely, by early involvement with the Spartan Project Office and Shuttle Safety Office.

SPARTAN 400 SPACECRAFT ACCOMODATIONS CHARACTERISTICS

Mission Life:	2 year mission with 1 year retrieval window (included in GFE)
Mechanical Accommodations:	
SP Mass:	Up to 910 kg
SP Physical Envelope:	See Figure 1.
The baseline Spartan 400 platform shall provide, for experiment mounting, a minimum of four 30 inch by 48 inch bays of mounting area with a minimum of 16 inches of carrier structure overhang available (within c.g. constraints). Each bay shall support up to at least 500 lbs. Multiple bays can be combined to support larger or heavier Science Payloads.	
SP avionics mass accommodation:	Up to 166 kg
SP avionics volume accommodation:	Up to 0.6 x 1.2 x 0.4 m
NOTE: Alternate mechanical configurations can be considered on a mission unique basis	
Power Accommodations:	
SP orbit average power (including heater power):	Up to 400 watts orbit average assuming fixed solar array pointed to within 30 degrees of the sun (on average) and 3 year End-Of-Life (EOL) output
SP peak power over all services:	1000 watts
Power Management:	PI responsible to manage power budget and solar array off-pointing to within orbit average constraint listed above
SP Power Distribution (@ unregulated 28 +7/-6 VDC):	
Operational Power Services:	
2 high power services:	750 watts/each
2 high power services:	250 watts/each
10 low power services:	90 watts/each
Heater Power Services:	
Orbiter survival heater power (un-switched):	10 services at 90 watts/each
Spartan Operational heater power (switched):	10 services at 90 watts/each
Thermal Accommodations:	

Thermal interface:	SP thermally isolated from SCB
Thermistors:	Up to 100 thermistor channels to SP
Guidance, Navigation and Control Accommodations:	
Orbit Inclination:	28 degrees to 57 degrees (STS limited)
Deploy Altitude:	Up to 500 km (STS limited)
Retrieval Altitude:	As low as 300 km
Orbit Eccentricity:	Circular
Control Type:	Three-Axis Stabilized
Targets:	Solar/Stellar/limited nadir
Maneuver Rate:	up to 15 degrees/min.
Baseline Attitude Sensor:	Star Tracker (can be mounted to SP)
Baseline Accuracy (pitch/yaw)*:	+/- 32 arc-seconds, 3-sigma**
Baseline Accuracy (roll)*:	+/- 121 arc-seconds, 3-sigma**
Baseline Jitter*:	+/- 1.15 arc-seconds, 3-sigma**
Baseline Attitude knowledge (pitch/yaw)*:	+/- 30 arc-seconds, 3-sigma**
Baseline Attitude knowledge (roll)*:	+/- 120 arc-seconds, 3-sigma**
* Pointing is with respect to the star tracker boresight relative to inertial space	
NOTE: **Sub-arcsecond pointing and jitter can be achieved with a science payload provided fine guidance sensor.	
Command and Data Handling Accommodations:	
SP Data volume to ground:	533 Mbytes/day (assuming six passes per day at six minutes per pass)
SP command volume from ground:	0.5 Mbytes/day (assuming six passes per day at six minutes per pass)
Communication System:	Omni S-band (up to 2.25 Mbits/sec downlink, up to 2 kbps uplink)
SP data processing:	None provided by SCB
SP data buffering/storage:	SCB to provide 750 MB (expandable)
SP commanding:	SCB can provide absolute time and relative time distribution of SP commands
Bit Error Rate:	Ground station dependent
Data Interfaces between SP and SCB:	
Redundant Mil-Std-1553	Up to 200 kbits/s for total experiment complement (includes commands and telemetry)
8 Redundant 422 High Speed Serial Interfaces (SP telemetry only)	2 Mbps, 1 Mbps, 500 Mbps, or 250 Mbps each
8 Redundant UART serial interfaces (RS 232 type UART using RS422 interface hardware)	Standard UART protocol 19200 or 9600 baud each
Redundant Time at the tone pulse	SCB can provide time synchronization pulse
Redundant Safehold Signal	SCB can provide signal to SP to indicate spacecraft is about to enter safehold

Spacecraft Integration and Test:	
Science Payload must be delivered fully functional and qualified to Spacecraft I&T by L-12 months	
Science Payload team required to support Spacecraft I&T from delivery through launch	
Science Payload team responsible to deliver and/or support all SP related spacecraft level procedures	
Baseline I&T flow at SC level	**Duration Included in GFE cost****
Mechanical Integration of the SP to SCB	1 wk
Electrical Integration of the SP to SCB	2 wks
Comprehensive Functional Testing	6 wks
EMI/EMC testing	1.5 wks
Acoustics	1 wk
Thermal Balance	1 wk
Thermal Vacuum	2 wks
Comprehensive Functional Testing	4 wks
****Note: Additional costing and schedule slips generated due to Science Payload requirements which extend the above scheduled durations are the PI's responsibility and are outside the scope of the fixed price GFE.**	
KSC Operations:	SP team responsible for supporting checkouts and tests at KSC
Nominal Mission Operations:	
PI to provide ground station(s), operations center(s), and operations support team	
Spartan will provide operations center at JSC for shuttle operations (checkout, deployment and retrieval)	
Spartan will provide operations center at GSFC for SCB trending and non-routine* operations	
Spartan team will provide hardware and software to be used at PI operations center(s) for spacecraft operations (included as part of GFE cost). Note, science specific data processing hardware and software not included.	
GFE costs assume flight operators trained via supporting I&T (two FTEs provided by PI team to support I&T starting at L-15 months)	
The Spartan team will maintain responsibility for operation through launch, initial checkout, deployment, and final checkouts for up to 30 days after launch. Responsibility will then transfer to the PI. Responsibility will transfer back to the Spartan team for the recovery of the spacecraft.	
Phase **Definition**	**Responsible Party**
Phase C/D ends at launch + 30 days	Spartan
Phase E begins at launch + 30 days ends at retrieval – 30 days	PI (routine ops) Spartan (non-routine ops*)
Retrieval begins at retrieval launch – 30 days	Spartan
Note: *Non-routine operations are defined as operations to rectify any anomaly for which there is no pre-approved procedure.	
De-integration:	SP de-integrated at GSFC after functional checkout (2 weeks)

Options Available to Add to GFE SCB:	
Propulsion System:	
A redundant hydrazine propulsion system is available	
I_{SP}: 222 seconds	
Propellant Mass: 564 kg	
Propulsion system capable of raising orbit to over 600 km circular (given 425km deploy and retrieval altitude)	
Propulsion system capable of supporting elliptical orbits with apogees as high as 900 km (given 425km deploy and retrieval altitude)	
Articulated Arrays:	
SP orbit average power (including heater power):	up to 1000 watts orbit average (3 year EOL output)
Enables full sky and nadir pointing	

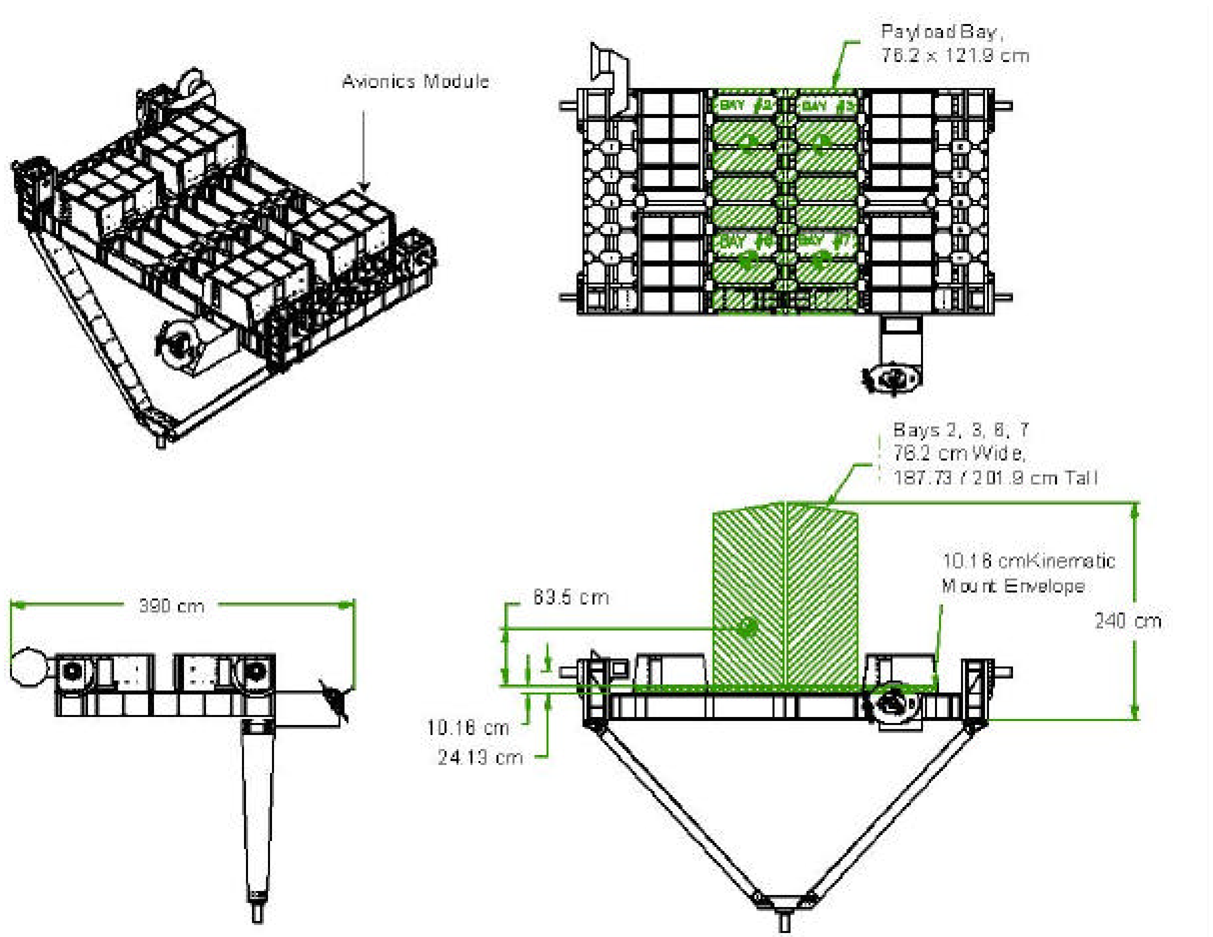

Figure 1. Spartan 400 Payload Envelope

The baseline Spartan 400 spacecraft bus includes four avionics modules, three for Spartan avionics and one for payload avionics. These modules support electronics on the interior side of a mounting plate with thermal louvers on the exterior. The avionics module locations are shown in Figure 1. The science payload(s) can occupy the four center bays, shown in Figure 1. Each bay is designed to support a 225 Kg load offset by one meter from the center of the bay. Multiple bays can be combined to support larger or heavier payloads. The cross-sectional area available to the science payload(s) is also shown in Figure 1. Science payloads may overhang the structure if the bridge-centered length does not exceed 390 cm.

Alternate mechanical configurations can be considered on a mission unique basis.

Spartan Costs

The costs associated with the use of fixed price GFE must be included in the proposer's proposed cost and is included in the SMEX cost cap. Mission unique costs identified in association with the Spartan 400 bus and associated services should include appropriate contingency/reserve and is also included in the SMEX cost cap.

GFE is offered for a fixed price. Table 1 shows GFE costs for both 1st and 2nd builds of Spartan 400 in FY 00 dollars. Note that these costs do not include accommodation of mission unique requirements. For a technical assessment and a cost estimate of mission unique requirements, contact the Spartan Project Office.

	Launch Date	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	Total
Baseline 1st Build	Sept '03	$4,417	$20,823	$23,347	$8,834	$2,524	$947	$2,208		$63,100
	Sept '04		$4,417	$20,823	$23,347	$8,834	$2,524	$947	$2,208	$63,100
Baseline 2nd Copy Build	Sept '03	$3,493	$16,467	$18,463	$6,986	$1,996	$749	$1,746		$49,900
	Sept '04		$3,493	$16,467	$18,463	$6,986	$1,996	$749	$1,746	$49,900
Options:										
Articulated Solar Arrays	Sept '03		$4,109	$4,634	$1,757					$10,500
	Sept '04			$4,109	$4,634	$1,757				$10,500
Propulsion System	Sept '03		$3,483	$3,928	$1,489					$8,900
	Sept '04			$3,483	$3,928	$1,489				$8,900

Table 1. Spartan 400 Spacecraft Bus Cost Summary

Note: The term "1st Build" refers to the Spartan 400 bus available as GFE for SMEX if the bus has not been selected for development under other programs. The term "2nd Copy Build" refers to the Spartan 400 bus available as GFE if the bus has been selected for development under another program. Unless announced otherwise through the SMEX Announcements web page <http://explorer.larc.nasa.gov/explorer/ppconf.html>, SMEX proposers must use costs associated with the 1st Build in their proposals. The articulated solar arrays and propulsion options are available as fixed price GFE only for the second copy build of Spartan 400. These items are available for the first build only as mission unique (non-GFE) options. For cost of mission unique options on the 1st Build, contact the Spartan office. If a Spartan 400 is selected for another program early enough during the proposal preparation period, proposers may be able to use the "2nd Copy build" cost in their proposals and the GFE fixed price costs for articulated solar arrays and propulsion system. Interested proposers should monitor the SMEX Announcements Page for an announcement of any Spartan 400 selections and its implications for SMEX proposers.

Further information on the Spartan 400 spacecraft bus and guidelines for how to fly on a Spartan are available at the Spartan Project website: http://spartans.gsfc.nasa.gov/ Contact point in the Spartan Project is: Mr. Donald Carson, Spartan Project Office, Code 860G, NASA Goddard Space Flight Center, Greenbelt, MD 20771, phone (301) 286-4968, email: Don.Carson@gsfc.nasa.gov